National Aeronautics and
Space Administration

John F. Kennedy Space Center

September 2000
FS-2000-09-11-KSC

NASASpinoffs

Whether you walk into your home, drive your car, visit your doctor or hospital, or indulge in recreation, you will likely come in contact with a product that is the result of technology first developed by NASA. NASA missions produce scientific and technical challenges that result in many technological developments. Since 1976, more than 1,300 documented NASA technologies have benefited U.S. industry, improved our quality of life and created jobs for Americans. They are called "spinoffs" as industry has taken the concept and applied it to commercial products. The Space Shuttle program alone has generated more than 100 technology spinoffs, utilized by medical, environmental, automotive, sports, computer and refrigeration markets.

With its engineering focus on Shuttle processing, Kennedy Space Center has developed materials to improve various aspects of Shuttle launching and maintenance, including safety. Since 1998, there have been 40 success stories at KSC. Among the more recent are the development of Molyseal, the Medevac Oxygen System (MOS) and a converter for fertilizer in 2000; a DNAnalyzer in 1999 and aerogel in 1998.

Molyseal, a Non-toxic Coating for Aluminum

NASA KSC sought to replace chromate-based coatings used on many of its spacecraft with safer coatings. Chromate-based conversion coatings are toxic and carcinogenic in nature. Chromates have been found to cause irritation of the respiratory tract, dermatitis, asthma and more.

The KSC Materials Science Division, under a Small Business Innovation Research contract with Lynntech, of College Station, Tex., developed a molybdate-based conversion coating for aluminum and aluminum alloys. Referred to as Molyseal, the coating does not contain chemicals or materials that are hazardous or toxic nor does it raise health and safety concerns. The coating can be applied by dipping, painting or spraying in short treatment times at low temperatures.

KSC envisions future NASA use of Molyseal on Space Shuttle ground support equipment at the launch pad, the Space Shuttle orbiter, solid rocket boosters and other NASA spacecraft and aircraft. Industrial applications include aerospace, boilers, air conditioners and aluminum construction materials.

A Transportable Oxygen System for Air-rescue

Also in 2000, the KSC Biomedical Office, which had developed the Medevac Oxygen System (MOS), transferred the technology to the U.S. Air Force. MOS provides a therapeutic oxygen supply to patients being flown aboard aircraft during a long-haul medevac scenario.

The system was developed to enable a C-130 astronaut medevac team to treat a Space Shuttle crew in the event of an emergency. Previously, medevac teams aboard U.S. military aircraft at the Space Shuttle Transatlantic Abort Landing sites were equipped to handle only three patients. Shuttle crews are normally larger.

The newly designed MOS can supply up to four patients, and systems can be "daisy chained." The C-130 provides a source of gaseous oxygen at about 400 pounds per square inch (psi) from its onboard liquid oxygen supply. The pressure of the gaseous oxygen is reduced by a regulator to 50 psi for distribution to each patient station. A flow controller and humidifier are provided at each station. The assembly can be attached to the litter or other patient-carrying device. The output from the humidifier connects to a no-rebreathing mask.

The entire system is packed and stored in a durable, plastic, waterproof case divided and padded to prevent damage during storage and transport.

Barry Slack (left), the biomedical electronics technician who created the Medevac Oxygen System kit, and Greg Lowdermilk (right), a program analyst for the DOD Manned Space Flight Support Office, check out a MOS kit. Slack consulted with Lowdermilk in designing the system.

The MOS can meet needs for patient oxygen delivery on a variety of airborne and surface platforms. Applications are envisioned on Hercules C-130 aircraft, C-141 and C-5 military aircraft, and helicopters.

Super Insulation for Space Brought to Homes, Cars

Imagine your current refrigerator with expanded storage space but still the same size. This could be possible through the development of a superinsulation blanket based on a space-age material called aerogel.

Through a Small Business Innovation Research contract, Aspen Systems Inc. of Marlborough, Mass., responded to NASA's need for an aerogel-based cryogenic insulation system with extremely low thermal conductivity that is flexible, durable and easy to use. The basic form of the insulation system is a blanket composed of aerogel-based composites and radiation shield layers. The final product can be a blanket, sheet or clam shell unit. The current primary market for the system is the cryogenic insulation market. Potential space applications include the Reusable Launch Vehicle, Space Shuttle upgrades, interplanetary propulsion and life support equipment.

For the refrigeration market, the product will allow thinner refrigerator walls, which will increase the refrigerated volume of the system. For the translucent panel and skylight market, the product will allow significant light transmissions with a fraction of the heat loss associated with the competing technologies.

Other potential markets include household freezers and ovens; offshore oil well underwater pipelines; shipping containers; refractory insulation for automotive firewalls, floorboards, exhaust systems, automotive air intake, head liners and race cars; noise suppression panels for aircraft and acoustic damping insulation for buildings; head phones; and much more.

DNAnalyzer – Cancer Detection Device

Another medical-related spinoff, the DNAnalyzer, resulted from a NASA/American Cancer Society partnership, the Space Station In-Flight Cytometry Project. To help decipher the medical mystery of why and how microgravity affects the immune system, NASA sought development of a machine that could separate and examine cells rapidly.

The existing device was too large – the size of a pool table – to place in an orbiting Space Station, so the partnership was formed to develop a far more compact flow cytometer. The resulting hardware could support biomedical experiments aboard the Space Station while advancing medical knowledge in cancer detection and treatment on Earth.

A Miami, Fla., business, RATCOM, Inc., pioneered the new triangular flow cell technology that improves resolution in flow cytometer technology. The cancer-fighting benefits of flow cytometry include the ability to evaluate cancer cells very early and to determine several important features, such as the sensitivity of the cancer cells to different chemotherapy drugs, the ability of the cells to grow, and their capacity for spreading.

The DNAnalyzer allows better understanding of the nature of a patient's tumor, thereby enabling better treatment. Dr. Awtar Krishan at the University of Miami, who was instrumental in defining requirements for the instrument, is carrying out studies on the application of the technology in cancer diagnosis and therapy.

Other potential uses of the new technology involve early detection of leukemia, chemo-sensitivity studies prior to chemotherapy, antibody analysis, and detection of pathogenic organisms.

Toxic Emissions Converted to Fertilizer

The newly issued U. S. patent has an environmental twist. The concept was devised by Clyde Parrish of Dynacs, Inc., the Engineering Development Contractor (EDC) at KSC, in response to a request from NASA to eliminate the hazardous waste stream that is captured in a scrubber when the toxic oxidizer is transferred from storage tanks into rockets and vice versa. This new scrubber captures nitrogen tetroxide in water where hydrogen peroxide oxidizes the resulting nitrous acid into nitric acid. The nitric acid is neutralized with potassium hydroxide to form the product potassium nitrate – a primary fertilizer material, with fewer impurities than commercially available fertilizers. The process can be up to 99 percent efficient.

The Nitrogen Tetroxide Scrubber has been installed in the Oxidizer Farm at Launch Pad 39A.

Plans at KSC call for the resulting fertilizer to be used on the orange groves that KSC leases to outside companies. The fertilizer will replace 10 percent of the amount annually purchased by KSC.

KSC plans to install the system at all scrubbers, and Cape Canaveral Air Force Station plans to install the control system at the Titan Launch Complex 40. The control system could also be used at Vandenberg Air Force Base in California and the White Sands Test Facility, New Mexico.

The system reduces emissions to less than 10 percent of previous levels, a plus on which Phoenix Systems International, Inc. (McDonald, Ohio), the new licensee, wanted to capitalize. The company anticipates using the NASA technology to apply to at least 40 percent of the country's coal-, oil-, and gas-fired boilers, and also

wants to establish a joint technology with a sulfuric dioxide (SO2) scrubber manufacturer.

Other Recent KSC Spinoffs

Advanced Lubricants: Sun Coast Chemicals of Daytona, Inc. (SCCD) is commercializing multiple products based on a biodegradable, non-toxic lubricant it originally developed to replace the Space Shuttle Crawler's standard lubricant. The X-1R Crawler Track Lubricant (CTL) led to an industrial product line of 19 separate specialty lubricants. The first three industrial products were:

- *Train Track Lube*, used to solve wear problems for the Florida Power Corporation's railroad system;
- *Penetrating Spray Lube (PSL),* used in applications where spray lubrication was needed for rust prevention;
- *Biodegradable Hydraulic Fluid (BHF)*, which has an oxidation life of 10,000 hours. BHF is being sold through Motion Industries, the largest industrial maintenance and equipment supplier in the U.S., to DuPont Corporation, Kitchens of the Ocean processing plant, as well as the sugar, agricultural, pulp and paper, forestry and sawmill, marine, mining, and heavy construction industries.

SCCD's newer retail product line has targeted the sports market, providing lubricants for gun cleaning, skates, air tools, fishing reels, bicycles, and an air conditioning retrofit kit. These spinoff products have been sold in retail stores nationwide.

SCCD is also negotiating with the television home shopping network QVC to market their products. In addition, the company is expanding into a marine line of products for boats, new products for racing cars, motorcycles, and go-carts, along with a multi-use handy pack.

Founded in 1989, SCCD established its reputation with its first product, X-1R Concentrate Friction Eliminator, developed for the NASCAR racing circuit, to protect engines and transmissions from heat and wear damage.

Automotive Insulation: BSR Products created special thermal protection system materials from the Space Shuttle Thermal Protection System and used it for NASCAR autos to protect drivers from extreme heat coming through engine areas.

Nuclear Magnetic Resonance (NMR): An image process technology used to sharpen the view of Jupiter and Saturn from Voyager and Mars from the Viking Probe was used by Michael Vannier, M.D., a former NASA engineer. He recognized the similarity of NASA's computerized image processing technology and nuclear magnetic resonance. With KSC's help he developed a computer program enabling NMR to scan body tissue for earlier diagnoses. Dr. Vannier feels that "satellite imaging" has opened a new window into the human body.

Parking Garage Automation System: Merritt Systems developed an obstacle detection system to ensure that robots avoid collisions in their workplace. The commercial potential ranges from use in robotic manufacturing systems to remote hazardous waste cleanup. The technology was also developed for a parking garage automation system that uses sensors to direct customers to garages and to control parking conditions.

Built-In Plant Nutrient: ZeoponiX, Inc. is manufacturing zeolite materials as a spinoff of NASA's advanced life support technology. The result is a growth medium-specialty fertilizer that improves plant performance.

NASA Medical-Related Spinoffs

America's space program has helped revolutionize the practice of medicine through improvements in blood pressure monitors, self-adjusting pacemakers, EKGs, exercise equipment and ultrasound images, as well as the items listed below.

Laser Angioplasty: From laser technology for remote sensing of the ozone layer, Advanced Interdentinal Systems, Irvine, Calif., developed a cool laser that uses ultraviolet light energy to operate on human tissue.

Digital Cardiac Imaging (DCI) System: Designed by Phillips Medical Systems International, DCI uses image processing technology on a monitor of the heart's regions, following a catheter as it moves. The technology was developed for NASA Earth remote-sensing satellites.

Digital Imaging Breast Biopsy System: Goddard Space Flight Center contracted with Scientific Imaging Technologies, Inc. (SITe) to develop a new advanced charge coupled device that could be manufactured at lower cost. SITe applied the NASA-driven enhancements to develop a technique called the LORAD Stereo Guide Breast Biopsy System, which incorporates SITe's charge coupled device as part of a digital camera system that "sees" a breast structure with x-ray vision.

Artificial Heart: The technology used in Space Shuttle fuel pumps led to the development of a miniaturized ventricular assist pump by NASA and renowned heart surgeon Dr. Michael DeBakey. The tiny pump – two inches long, one inch in diameter and weighing less than four ounces – has been successfully implanted into more than 20 people.

Diagnostic Instrument: NASA technology was used to create a compact laboratory instrument for hospitals and doctors' offices that more quickly analyzes blood, doing it in 30 seconds instead of 20 minutes.

Bioreactor: Developed for Space Shuttle medical research, this rotating cell culture apparatus simulates some aspects of the space environment, or microgravity, on the ground. Tissue samples grown in the bioreactor are being used to design therapeutic drugs and antibodies. Some scientists believe the bioreactor will routinely produce human tissue for research and transplantation.

Infrared Thermometer: Infrared sensors developed to remotely measure the temperature of distant stars and planets led to the development of the hand-held optical sensor thermometer. Placed inside the ear canal, the thermometer provides an accurate reading in two seconds or less.

Lifesaving Light: Special lighting technology developed for plant growth experiments on Space Shuttle missions is now used to treat brain tumors in children. Doctors at the Medical College of Wisconsin in Milwaukee use light-emitting diodes in a treatment called photodynamic therapy, a form of chemotherapy, to kill cancerous tumors.

Prosthesis Material: Responding to a request from the orthopedic appliance industry, NASA recommended that the foam insulation used to protect the Shuttle's external tank replace the heavy, fragile plaster used to produce master molds for prosthetics. The new material is light, virtually indestructible and easy to ship and store.

Insulation Pumps: Implantable and external insulin pumps, which are based on technology used on the Mars Viking spacecraft, have aided insulin-dependent diabetics. These computerized pumps can infuse insulin at a pre-programmed rate, allowing more precise control of blood sugar level and eliminating the need for daily injections.

Other Spinoffs

Infrared Camera: A sensitive infrared hand-held camera that observes the blazing plumes from the Shuttle also is capable of scanning for fires. Designed by the Jet Propulsion Laboratory Center for Space Microelectronics in partnership with Amber, a Raytheon company, the camera can also be used for night vision and navigation. During the brush fires that ravaged Malibu, Calif., in 1996, the camera was used to point out hot spots for firefighters.

Rescue Tool: Rescue squads have an extrication tool to help remove accident victims from wrecked vehicles. The hand-held device requires no auxiliary power systems or cumbersome hoses and is 70 percent cheaper than previous rescue equipment. The cutter uses a miniature version of the explosive charges that separate devices on the Shuttle.

Jewelry Design Equipment: Jewelers no longer have to worry about inhaling dangerous asbestos fibers from the blocks they use as soldering bases. Space Shuttle heat shield tiles offer jewelers a safer soldering base with temperature resistance far beyond the 1,400 degrees F. generated by the jeweler's torch.

It Began with the Apollo Program

The quality of American life took a giant leap forward with the technologies emerging from the Apollo program, especially in health care. Here are some of the contributions:

Kidney Dialysis: Dialysis machines were developed as a result of a NASA-developed chemical process to remove toxic waste from used dialysis fluid.

Physical Rehabilitation: A cardiovascular conditioner developed for astronauts in space led to the development of a physical therapy and athletic development machine used by football teams, sports clinics and medical rehabilitation centers.

Water Purification: The technology for purifying water, used on the Apollo spacecraft, now is used to kill bacteria, viruses and algae in community water supply systems and cooling towers. Also, filters mounted on faucets can reduce lead in water supplies.

Vacuum Metallizing Techniques: These led to an extensive line of commercial products, from insulated outer garments and packaging for foods, to wall coverings, window shades, life rafts, candy wrappings, reflective blankets and photographic reflectors.

Cordless Power Tools: A NASA requirement during the Apollo program, re-chargeable tools were developed to permit astronauts to do repairs in space.

More information about these and other spinoffs of NASA technology can be found on these Web sites:

http://technology.nasa.gov/scripts/nls_ax.dll/w3SuccList()

http://nctn.hq.nasa.gov/success/msg00020.html

National Aeronautics and
Space Administration

John F. Kennedy Space Center